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EVALUATION OF CALORIE REQUIREMENTS FOR RANGER TRAINING AT FORT BENNING, GEORGIA

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In response to a request to evaluate the requirement for an increased ration allowance for trainees by the Ranger Department, United States Army, a study was conducted throughout one training cycle on the men enrolled in the course. Body weights, skinfold thicknesses, selected body circumferences, and urinary chemistry values were measured several times from pretraining until graduation. Treadmill performance tests were conducted, blood samples were obtained for analysis, and additional anthropometric parameters were measured pre and post training.

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20. ABSTRACT

The data confirmed that the Ranger trainees have large losses of body weight during portions of the 8-week training cycle. Since the training protocol has extended periods of caloric restriction (some quite severe), body weight loss was expected and therefore only the magnitude and the physiological significance of these losses required documentation. Body weights decreased an average of 9.4% (6.8 kg or 14.9 lb) by the end of the 12-day caloric restriction-jungle exercise. Some men lost over 15% of body weight. Body composition data indicated that 57% of weight loss was fat; however, data revealed that large percentages of the losses were water and protein, an intolerable loss. A small subpopulation indicated during interview that the men consumed about 12,100 kcalories from sources outside of the military dining room before the jungle exercise. This would be equivalent to 1.57 kg (3.5 lb) of body weight per man. Without the supplemental calories from outside sources, weight losses could have averaged nearly 12%. A loss for otherwise normal weight adults that appears excessive.

From the limited blood biochemical constituents examined, the indications of the nutritional stress were: the increase in percentage of trainees with less-than-acceptable values for hematocrits, serum iron concentrations, and transferrin saturation; the slight but significant decrease of serum proteins which suggests a depletion of labile protein stores; and the marked increase in serum potassium, and decrease in serum phosphorous indicating the presence of a significant though transient metabolic acidosis. Elevated urinary specific gravity in the specimens indicated that the body was attempting to conserve water.

The various measurements of physical performance capacities on the treadmill showed a decrement of 10 to 15% immediately after the caloric restriction-jungle training. Although several factors including fatigue, metabolic acidosis and reduced total body water may have contributed to these decreases, the major portion of each of the decrements was still observed 3 to 4 days after training was completed when water balance should have been normal, the metabolic acidosis should have been corrected and the men had the opportunity to obtain a few good nights of rest. The loss of lean body mass due to catabolism of tissue protein to satisfy a caloric deficit would not be corrected in this time frame. The effects of fatigue after the strenuous field exercise would be anticipated; but the longer term detrimental effects upon performance should be prevented if possible.

These data provided the basis for recommending a 10% increase in rations during the Ft. Benning/Camp Darby phase and a 15% increase during the remainder of the training when reduced rations are not required by the training protocol.

ABSTRACT

In response to a request to evaluate the requirement for an increased ration allowance for trainees by the Ranger Department, United States Army, a study was conducted throughout one training cycle on the men enrolled in the course. Body weights, skinfold thicknesses, selected body circumferences, and urinary chemistry values were measured several times from pretraining until graduation. Treadmill performance tests were conducted, blood samples were obtained for analysis, and additional anthropometric parameters were measured pre and post training.

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PREFACE

We wish to thank COL David E. Grange, Jr., Commander of the Ranger Training Center, Ft. Benning, Georgia and his staff for cooperation and outstanding support. A particular expression of gratitude is extended to the following officers assigned to the Ranger Training Center, Ft. Benning: LTC W. R. Smith, Executive Officer; MAJ Dean W. Knox, Operations Officer; and CPT John C. Grimsley, Project Officer for the Study; and to LTC William D. Old, II, Commander, Florida Ranger Camp, Eglin AFB, Florida. In addition valuable support was provided by personnel from the Fort Benning MEDDAC then commanded by COL George S. Woodard, MC and later by COL John W. White, MC. In particular the support of COL Olin C. Dobbs, Jr., MC, Chief, Preventive Medicine was greatly appreciated.

The preliminary results and recommendations arising from this study were discussed with LTC Smith and CPT Grimsley of the Ranger Training Center; LTC Richard B. Stoltz, MSC, USA Infantry Center; and COL Olin Dobbs, MEDDAC immediately after completion of the study. The formal recommendations were forwarded to the Ranger Department, US Army Infantry Center in March 1976.

The three year delay in organizing and completing the study and in providing the findings and recommendations following submission of the request is most regretted. The request for a study had been telephonically provided USAMRNL about one month after initial submission. At that time, USAMRNL, Denver, Colo. was scheduled for termination with transfer of functions to the Letterman Army Institute of Research, San Francisco, Ca. before the end of CY 73. Many projects that could best be completed from the Denver location had been scheduled by the Bioenergetics and Chemistry Divisions. This study at the Ranger Center was felt to be important and was accepted with the understanding that it would have some limitations. Unfortunately personnel losses without replacement prior to the transfer of functions from Denver to San Francisco were greater than expected. After transfer the delay in replacement employment and/or assignment was far longer than was projected. This resulted in significant delays in the analysis of collected specimens and data. Many of the Bioenergetic and Chemistry Divisions personnel who contributed significantly to the data gathering did not transfer - hence data analysis had to be completed by others.

Due to the multiple changes in personnel many individuals have been involved in the completion of the written report. They have each contributed significantly and a strong word of thanks is indicated to include in the sequence of support: Catherine M. Robson; William J. Canham; Ann L. Wilkinson; Lottie B. Applewhite; J. Elaine Watson and Wanda R. Zweigle.

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INTRODUCTION

Background

Daily heavy physical exercise for extended periods increases caloric requirements. If the calories are not supplied in the diet, losses of body weight will occur. Large weight losses by normal men during an extended period of severe caloric restriction reduce physical performance capacities. Recovery and return to normal capability may require several months.[1] The amount of weight loss necessary to reduce performance and the positive influence of heavy physical training during an extended period of caloric deficit have not been resolved. It is known that the amount of weight loss resulting from caloric-deficient diets varies from person to person.

Ranger training for military personnel demands physical endurance because of activities, long hours, and several periods of caloric restriction. Ranger training is divided into three phases: (a) 21 days at Ft. Benning for physical conditioning and basic tactics, (b) 17 days in the mountains of North Georgia for mountain tactics and problems, and (c) 18 days in Florida (6 days for classroom instruction and preparation, and 12 days for a jungle exercise).

A nutrition survey was conducted in 1964 by the U.S. Army Medical Research and Nutrition Laboratory[2] on the Ranger trainees during the Ft. Benning phase of training. Food consumption averaged 4,400 kcal/day including 270 kcal/day from outside-of-dining hall consumption. The 4,130 kcal/day consumed in the dining hall included the normal daily issue plus a 10% increase authorized by the post surgeon and issued surplus commodities. Calorie expenditure averaged 4,850 kcal/day based on the measured calorie intakes, body weight changes, and energy costs of activities recorded during time-and-motion studies. A 25% increase in the daily ration issues was recommended and approved in 1965 by The Surgeon General (TSG), Department of the Army. This increase was reduced to 15% in 1967 by TSG in accordance with changes in AR 31-200. It was assumed that the alterations would provide as many calories as the previous increased issues; and the findings of the 1964 survey were judged to be "no longer current." The Ranger Department, in their request for continuation of the 25% increase, stated that the Ranger student was working 132 hours per week in 1969 compared to 102 hours per week in 1964 since training had been reduced from 9 weeks to 8 weeks without deleting any part of it. The Army Food Center, in 1969, rejected a request for continuation of any

1. Keys, A.A., et al. Human Starvation. Minneapolis: Univ Minn Press, 1951

2. Consolazio, C.F., et al. USAMRNL Lab Report No. 291, FGH, Denver, 28 Jan 1966.

increased issues on the basis that the current issue of 4,600 kcal/day exceeded the previously established requirement of 4,500 kcal/day The Army Food Center incorrectly assumed that 4,600 kcal/day derived from the Master Menu was equivalent to that amount available for individual consumption within the dining facility. Another request for a nutrition survey was initiated during April 1973 by the Ranger Department. The request stated:

> "The strenuous nature of Ranger training has not been reduced, if anything, it has been increased. The Ranger course consists of approximately 1,007 hours of actual instruction in 8 weeks and 2-1/2 days. This is an average of 17 hours per day which is twice the activity per man when compared with other school students. Most of this instruction is practical exercise conducted in the field under simulated combat conditions with only as much classroom and bleacher instruction as necessary. During the course the student eats 133 meals. Of these, 81 are prepared in the mess halls and the rest of the time he subsists entirely on either Meal, Combat, Individual (MCI) or Food Packet, Long Range Patrol (LRP) rations. As a result of the arduous and physically demanding training and current level of ration issue, the Ranger Department consistently receives major adverse student comments citing the insufficient amount of food provided during the Ranger Course. This situation is further magnified during the wet, cold winter months and whenever a class is comprised of predominantly junior enlisted men such as Class 8-73 in which the average age is 23 years.
>
> Because of the continuing adverse student comments the Ranger Department feels that Ranger students are not receiving adequate nutrition for sustained vigorous physical activity as defined in Para. 4C, AR 40-25, Aug 1972----. A one-third ration/day increase is recommended for the reasons already stated herein plus the fact that Ranger training is conducted in a remote and isolated environment which negates the Ranger students' supplementation with food from outside sources."

Presently the Ranger training plan consists of 6 days of caloric restriction (3 days of 2 meals/day and 3 days of 1 meal/day) during mountain training and one 12-day exercise with 1 meal/day during jungle training. The Ranger Department has indicated that individual weight losses of 26 pounds were not unusual during this training.

During the caloric restriction phase, meals are provided in the form of operational rations either Meal, Combat, Individual (MCI) or Food Packet, Long-Range Patrol (LRP). The average caloric content of the MCI is 1,185 kcalories if the entire contents of the meal are consumed. The average caloric content of the LRP is slightly less at 1,103 kcalories per packet if the entire contents are consumed. During the 12-day jungle training exercise during which only one meal/day is normally provided, provisions are made for the addition of one or two more meals during the 12-day period if the men appear to be in need of additional nourishment. During the training cycle studied, 13 MCI meals were provided for the 12-day exercise. To insure an adequate intake of water during the jungle dietary restriction phase, each trainee was issued two canteens and they were encouraged to drink as much water as possible.

Objective of Study

The major objective of this study was to determine if increased rations would be required to prevent any deterioration of the soldier's physical or nutritional status during Ranger training. To evaluate the effects of extended periods of caloric restriction during heavy physical training, the following changes were monitored: (a) body weights, (b) selected biochemical parameters of the blood, (c) skinfolds and selected anthropometric measurements, (d) urine chemistry values, and (e) maximum and submaximum work performance during treadmill testing.

Military Justification

This Activity has the mission to evaluate the rations provided to military man/woman to ensure that adequate nutrition will be provided to him/her under a variety of duty requirements and that his/her effective military performance will not be impaired by improper nutrition.[3,4] The garrison or Class A ration has been adequate for most duty assignments, however it was observed in 1964 that the Ranger trainees at the Ranger Training Center required additional rations.[2] Since this increased food allowance has been terminated, it was necessary to obtain current data to reevaluate the daily requirements of Rangers during training. This intensive training is intended to increase physical condition and efficiency as well as improve military skills and self-confidence. However, excessive body weight losses during training may be detrimental to one's physical and mental well-being and learning capability. Some weight loss is expected since dietary limitations are imposed to simulate combat situations.

3. Medical Services Nutritional Standards, AR 40-25, August 1972.

4. R&D. DOD Food Research Development, Test and Engineering Program, AR 70-3, June 1975.

METHODS

The Ranger trainee class of 31 July through 27 September 1973 was studied. Of the 298 male applicants, 212 were enrolled and 135 completed the 56-day training cycle. The graduates included 8 Laotions, 2 Indonesians, 2 Canadians and 108 US Army and Marine Corps personnel. Questionnaires regarding date and place of birth, race, military history and occupation, smoking history, et cetera, were administered to the early arriving student trainees during the week before training. The average age of the 135 men who completed training was 23.94 ± 3.92 years and their heights averaged 175.7 ± 7.0 cm (5'9.2" ± 2.8"). Control or pretraining and posttraining measurements were made at Ft. Benning, Georgia; intermediate measurements were obtained at the Frank Merrill Mountain Camp in North Georgia and at the Ranger Jungle Camp, Eglin Air Force Base, Florida (Table 1).

Body weights were obtained in the nude fasting state after voiding. Skinfold thicknesses were measured on the right and left triceps and inferior to the tip of scapula, right and left. Body circumferences were obtained at the xiphosternal level of the chest, waist, and buttocks, plus extremity circumferences of the forearms, biceps and calves. The lateral chest, bihumeral, and bideltoid diameters were measured.

Each day that the men were weighed, a specimen of the first urine voided in the morning was obtained. Specific gravity was measured with a refractometer and pH by a commercial test strip. Test strips were used to obtain values for glucose, ketones, blood and protein on these samples. Approximately 25 ml of blood were drawn from each available man after an overnight fast before training and again on the morning following the 12-day caloric restriction-jungle phase. Each of these blood specimens was divided into two samples: First, an ethylene diamine tetraacetate tube for hemoglobin and hematocrit determinations and second, a serum sample for the determinations of total protein (refractive index method), vitamin C, iron, iron binding capacity, percent iron saturation, calcium, phosphorus, sodium and potassium.[5]

Sixty-two men from the early arrivals were selected for measurement of maximum work capacity on the treadmill after a physician had obtained and evaluated an electrocardiogram of each man. This test was repeated on 14 of these men one day after the caloric restriction-jungle phase and again on 25 men (including the 14) who completed the cycle 3 days after training. The treadmill test was a modified Balke technique.[6] After monitoring respiratory gases for 5 minute through

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5. Sauberlich, H.E., et al. Laboratory Tests for the Assessment of Nutritional Status. Cleveland: CRC Press, Inc., 1974.

6. USAF SAM Proj. #21-32-004, Rpt #1, Randolph AFB, April 1952.

the continuous gas pattern analyzer,[7] the man walked at 3.4 miles/hr on a level treadmill. After each minute, the treadmill was raised 1% in grade until the man was unable to continue the walk and the subject terminated the activity. Continuous measurements of pulse and respiratory rates, expired gas volume, oxygen and carbon dioxide content of the expired gas, and environmental humidity and temperature were recorded on computer input tape for the 5-minute preexercise sitting rest period through 5 minutes of postexercise recovery. These data were then processed by computer to obtain the values for maximal work capacity. In addition, calculations were made by using the 10 to 11 minute (10% grade) values for a standardized submaximal work level. Copies of the Ranger Score Sheets (cadre and peer ratings of each trainee for performance during field exercises in each phase and the physical training test score) were obtained. Correlations of the appropriate weight changes and initial body weight with the final total score and various parts of the score were performed.

The data obtained from only the men that completed training were statistically evaluated by using paired or unpaired-T tests, analysis of variance, linear correlation analysis and Neuman-Keul's Multiple Range Tests as appropriate. Significance was tested at the 5% confidence levels.

RESULTS

Body weights and circumferences (Table 2) significantly decreased from pretraining through the mountain phase and then increased during the 6 days in the jungle camp before the field exercise. At this time, the chest and buttocks circumferences returned to pretraining values while the weights and waist circumferences were slightly but significantly less than the first values. The 12-day field study with caloric restriction reduced body weights 5.93 kg (13.0 lb) concomitant with reductions in the circumferences. The total weight loss from the start of the training through the restriction period averaged 9.4%. The individual data showed that 43% of the American men lost over 10% of their initial weights and 4% of these men lost over 15%. The 5 men with the largest weight changes had an average loss of 13.9 kg (30.6 lb - ranging from 23.8 to 38.7 lb). Although the average weight of the total group returned to within 1.5 kg (3.3 lb) of their initial weights, these 5 with the largest losses were still between 11.8 and 23.5 lb (average 19.0 lb) below their pretraining weights. During restriction, the chest circumference was reduced 4.03 cm (1.6 inches) but returned to within 1.5 cm of the original measurement after day 1 of recovery. The waist measurement was decreased 4.77 cm (1.9 inches) while the buttocks was reduced 3.27 cm (1.3 inches) during the jungle exercise. After one day of normal military meals, the buttocks remained unchanged while the waist increased, remaining 3.11 cm (1.2 inches) less than the first measurement.

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7. Nelson, R.A., et al. USAMRNL Report No. 318, FGH, Denver, May 1968.

Although all of the decreases in the extremity circumferences and body diameters (Table 3) measured only before and after training were highly significant, the percent changes ranged from only 1.3 to 3.5% except for the biceps. The bicep circumferences were reduced by over 6.3% for both the right and left arms.

The bilateral skinfold thicknesses, reflecting the amount of body fat (Table 4), decreased from the start of the training through the entire measurement period except for an increase at the evaluation conducted at the end of the prerestriction-jungle phase. The thicknesses of the triceps were reduced by 37.0% (right) and 38.4% (left) and the subscapulae by 28.6% (right) and 29.3% (left) of their initial values. Of the total decreases in skinfold thicknesses, 21 to 25% occurred during the Benning phase and another 40 to 52% was found after the mountain training. However, skinfolds increased during the first 6 days of the jungle phase resulting in a net 50 to 54% of the total decreases occurring prior to prolonged caloric restriction. Thirty to 38% occurred during, and the remaining 10 to 20% after, the caloric restriction portion of the jungle phase.

Comparisons of body weight and body fat changes estimated from anthropometric data (Table 5) indicate that essentially all of the weight losses through the mountain training phase could be attributed to loss of body fat. During the 12-day caloric restriction-jungle exercise, 60.4% of the weight loss appeared to be fat. The total fat lost was about 26% of the body's original fat stores, while lean body mass losses were about 3.7% of initial amount present.

The urinary specific gravity levels (Table 6) were relatively high throughout training and they showed a minute decrease on the last day of measurement. The highest specific gravities (significantly increased) were at the ends of the Ft. Benning and the jungle caloric restriction phases. The pH of the urines varied within the normal range. All of the positive reactions for glucose, ketones, blood, and protein were trace or light. There were significant incidences of the presence of ketones immediately after caloric restriction at the end of the mountain and jungle phases. No significant incidences of positive reactions for urinary glucose or blood were observed. All positive reactions for glucose were from one trainee (4 of 8 specimens). The greatest incidences of positive urinary protein were observed immediately after the caloric restriction jungle exercise and after the caloric restriction during mountain training. In both instances, the incidence of urinary protein decreased with time and by the end of the study the incidence was not significantly greater than at the initiation of training. The urine specimens from each man showed 3 men with 6 positive, 1 man with 5 positive, 10 men with 4 positive, and the remainder of the men with 3 or less positive protein reactions.

Changes observed in the blood and serum values in samples obtained during the week before training and again on the morning following the 12-day caloric restriction-jungle training can be observed in Table 7.

The serum vitamin C concentrations were significantly increased by 36.7% when comparing the posttraining value to the pretraining level. Although the hemoglobin values were significantly increased (but only 2.7%) after training, the hematocrit was unchanged. Iron binding capacity decreased only 3.4%, which was significant, but serum iron concentration and transferrin saturation remained unchanged. The 6.5% decrease of serum phosphorus, 26.8% increase of serum potassium and 2.3% decrease of serum protein were highly significant while serum calcium and sodium concentration did not change. The limited biochemical values obtained were evaluated using the criteria established for the National Nutrition Survey[8]. The results are contained in Table 8. Serum ascorbic acid values were acceptable for all trainees, both pre and post training. Values for total proteins were all acceptable pretraining with one "less than acceptable" post training. Pretraining, 9.2% of the hemoglobin values and 31.3% of the hematocrit values were "less than acceptable" while only 3.7% of the hemoglobin but 36.6% of the hematocrit values were "less than acceptable" immediately after training. There were 4.7% of the serum iron values and 2.3% of percent saturation of transferrin values "less than acceptable" pretraining but 10.5% and 7.7% respectively, were "less than acceptable" immediately post training. In Table 9, the number of trainees with "less than acceptable" values for two or more of the six parameters evaluated is presented.

The maximum work performance measured provided the data presented in Table 10. The time required to complete maximum work performance did not permit evaluation of more than 14 men on the day immediately following completion of training. These same 14 men and 11 others were again evaluated 3 or 4 days later in the recovery phase. The work times of the men were significantly less after training, both immediately for 14 men and 3 to 4 days later for 14 and 25 men (includes the 14 men). Since the time to reach maximal performance was reduced, the work oxygen consumption was decreased 26.3%. Both work oxygen and total (sum of work and the 5-minute postwork oxygens) oxygen consumptions were significantly increased during recovery compared to immediately after training. However, the recovery values were still significantly less than the control values. The Balke Index, which is a measure of the amount of work performed, was reduced over 16% immediately after training and then increased significantly by 7% but did not reach the pretraining values. Physical Fitness Index (PFI) scores based on recovery heart rates were not changed significantly. The data listed in Table 10 for the 36 men in the pretraining phase were obtained from men who failed to complete the training cycle.

The resting, submaximal, and maximal work heart rates (Table 11) were all significantly decreased immediately after training and all, except for maximal, had returned to normal when they were tested 3 days later. Respiration rates were minimally affected.

8. O'Neal, R.M., et al. Pediatr Res 4:103, 1970.

The ventilation volumes (Table 12), both under ambient and standard conditions, were reduced immediately after training and these decreases were significant for the submaximal and maximal work. After 3 days of recovery, the resting and submaximal work ventilation volumes were significantly higher than either the pretraining values or immediately-after-training values. The maximal work values, although significantly increased over the immediately-after-training values, were significantly less than the control values.

The data in Table 13 show that respiratory quotients were increased for the recovery measurement at rest and for the immediately-after-training and recovery times during submaximal work. Carbon dioxide production was significantly reduced during maximal work both immediately after training and 3 days later but was significantly increased for the recovery measurement at rest and for submaximal work.

Oxygen consumptions in liter/min and ml/kg/min (Table 14) were significantly increased at rest for the recovery measurement. For submaximal work, the oxygen consumptions in liter/min were reduced immediately after training and 3 days later; but this reduction disappeared when consumption was adjusted for body weight. Maximal oxygen consumptions were significantly reduced at both times after training although some increase had occurred between the immediate and the 3-day posttraining measurements.

Few significant differences were obtained when comparing the 36 men who were dropped before the sixth week of training to the 25 who completed the training. Both the work and total oxygen consumptions (Table 10) were 15 and 12% lower, respectively, for the nonfinishers. The two indices of performance capacities were significantly lower for the nonfinishers (Balke, 7%; PFI, 12%). The nonfinishers, also, had increased respiration rates (13.4% - Table 11) and respiratory quotients (5.9% - Table 13) and decreased oxygen uptakes in liter/min (6.8% - Table 14). However, the 5.6% lower oxygen uptakes in ml/kg/min were not significant.

We evaluated a total of 273 men who had reported to the Ranger Department as potential participants in this training cycle. Some potential trainees were not able to successfully complete the physical fitness test given prior to the training cycle while a significant number were eliminated during the training cycle. Overall, 135 men completed the cycle while 138 personnel did not. Of the 135 finishers only 120 were considered to have completed the cycle with sufficient demonstrated expertise to warrant graduation. Tables 15 and 16 present some comparisons between the finishers and the non finishers. Of the non finishers, 8.9% had serum iron values and 8.0% had transferrin saturation values "less than acceptable" as compared to 4.7% of serum iron and 2.3% of transferrin saturation values "less than acceptable" for the finishers (Table 8). Comparison of the heights and weights of the two groups indicated that they were not significantly different (Table 16 and Figure 1). It is of interest however that the mean serum ascorbic acid value obtained in the pretraining period was significantly lower (= <0.005) for the non finishers when compared to the finishers. A complete evaluation could not be performed on the non finishers at the time they were dropped from the cycle.

The dietary restriction portion of the jungle training phase was most challenging from a physiological and psychological standpoint. By knowing the amount of weight lost in this period and the food intake permitted during this 12 day period (13 MCI meals with an average caloric content of 1,200 kcalories/meal) and assuming all food was consumed by each individual it should be possible to calculate the energy expenditure during this period. Table 17 presents the average daily caloric deficit, daily caloric expenditure and average daily caloric expenditure per kilogram of weight. The data for the ten oriental officers who participated in the training cycle and data from one of the U.S. Army personnel have been excluded. Detailed data for the remaining 124 finishers are contained in Appendix D and are partially depicted in Figure 2. In Table 17 those individuals losing more than 10% of their initial weight as determined immediately after completion of the dietary restriction period are compared with those losing less than 10% of their initial weight. For all measures listed except "average weight" there were significant differences between the two groups. The average daily energy expenditure for both groups combined was calculated to be 4,035 kcalories. In equating body weight loss to energy equivalents two factors were used. It has been demonstrated that the weight loss of adults of normal weight during the initial periods of starvation or semistarvation is principally water[9]. As the period of starvation or semistarvation continues beyond three days, the weight loss due to excess water loss gradually becomes negligible until the caloric equivalent of 1 kg of weight lost is approximately 7,700 kcalories. On refeeding, weight, in the form of water, is rapidly regained. During this study the group as a whole regained weight during the 6 days in the jungle prior to dietary restriction, (Tables 2 and 3). However 22 of the 124 men continued to lose weight or failed to gain weight during this 6 day period. It was then assumed that the weight loss that they experienced in the dietary restriction phase was equivalent to 7,700 kcal/kg. Based on body composition estimates the total weight loss represented approximately 65% fat and lean body mass with the rest water; hence, for the other 102 men a factor of 5,005 kcal/kg was used in calculating the energy equivalent of the weight loss. It should be noted that of the 22 men who lost or failed to gain weight during the prerestriction jungle phase 9 were from the group that lost less than 10% of their body weight.

DISCUSSION

This study of the Ranger trainees through one complete cycle of

9. Consolazio, C.F., et al. Am J. Clin Nutr 20:672, 1967.

training was designed to determine if these men required an increased ration allowance. Since the training is vigorous and includes periods of reduced rations (3 days with 2 Meal, Combat, Individual (MCI) packets/day and a total of 15 days with only 1 MCI/day), nutritional stress and accompanying weight loss was expected and had been reported by the training cadre. It was necessary to document the amount of body weight loss and to determine if either weight loss or training had any detrimental effects upon the man's health or performance capabilities. This was accomplished by measuring body weights, skinfolds, anthropometry, blood and urine biochemical properties, and treadmill performances at various times before, during, and after training.

Body weight loss reflects both caloric deficits and body water losses. If the caloric deficit reduces only body fat stores, its effects may not be detrimental; however, since loss of body protein will reduce performance capabilities and resistance to diseases, the loss may have residual effects. Excessive water loss is even more critical for the health of the man because it alters the body's temperature regulating mechanism. With accompanying salt losses, the reduction of the body's water content may produce heat cramps, heat exhaustion, and heat stroke[10].

The average body weights were reduced 9.4% by the end of the caloric restriction-jungle training phase. Two men lost over 17% of their initial weights. Estimates based on the anthropometric data indicated that 57% of weight loss was fat (3.85 kg) and 4.7% was lean tissue mass (0.32 kg). However, an additional 2.59 kg, not attributable to fat, or lean, was lost. The rapid recovery of 1.68 kg after only one day of consuming normal dining hall meals suggests that most of this loss was water. Since the training personnel at Ft. Benning did not feel that the men could be prohibited from eating at outside-the-dining hall sources, further evaluation of water changes and body protein tissues could not be made. Two days of reported fairly heavy ad libitum consumption from all sources during recovery reduced the average weight losses to less than 1.51 kg (3.5 lb). However, five men who had lost between 23 and 39 lb were still between 11.8 and 23.5 lb below their initial weights. Although the average urinary specific gravity levels were only slightly increased, 25% of the men had urinary specific gravity levels over 1.035 that indicate that these men may have been conserving body water that was approaching critical levels. It should be noted that the trainees had been back in the jungle base camp for a few hours before the urine and blood samples for the immediate post dietary restriction phase were obtained. High fluid intake in this period could have reduced the specific gravity of the urines from some of these men. The higher incidence of urinary ketones immediately after both the mountain and jungle caloric restriction phases indicates excessive fat catabolism resulting from exogenous energy

10. The Etiology, Prevention, Diagnosis, and Treatment of Adverse Effects of Heat. TB MED 175, 25 April 1969.

deficiency. Negative water balances accompanying carbohydrate and/or energy deficiency ketonuria are well documented.[9, 11-13] The increased incidence of proteinuria during the training cycle undoubtedly reflected the age of the trainees and the vigorous physical training.

Although food consumption was restricted to the military dining hall or field rations during the various training phases, the trainees had breaks of one day or less between the three phases which provided them with opportunities to purchase and consume other foods. Fifteen of the men were questioned for recall information on second servings of food items in the dining hall and food consumed from other sources. The consensus of their opinions was that the dining halls served an adequate amount of food during the first phase (Ft. Benning and Camp Darby), with milk, bread and butter ad libitum, and seconds available on several of the main entrees including meats. This was reflected in their reporting only 3,800 ± 2,890 kcal/man or about 190 kcal/day of food purchased from other sources during this phase. The men stated that the smallest portions of foods (for example - only 1 glass of milk per meal including breakfasts) were served at the mountain camp dining hall. The 15 interviewed men purchased 8,340 ± 5,420 additional kcalories during this phase or about 460 kcal/man/day. These men indicated that, although fewer second servings were available at the jungle camp, the initial servings were larger than at the other dining halls. The total average consumption of foods from sources other than the dining hall for the jungle phase until graduation was 6,610 ± 6,610 kcal/man, which averaged about 330 kcal/day. However, this period included 12 days of a jungle exercise during which intake was restricted to issued operational meals. If these 12 days are deleted, purchased calories averaged 830 kcal/man/day. These additional purchased calories would be equivalent to 1.1, 2.4, and 1.9 lb of body weight for the three consecutive phases of the training. Although 3.5 to 4 lb additional body weight loss before the jungle restriction exercise may sound insignificant, this loss along with that observed would have totaled about 12% of the men's initial body weight by the end of the jungle training.

The physician coauthor was present at the time of the blood drawing immediately post restriction and was quite impressed by the general loss of skin turgor, particularly of the arms and legs, while the tongues and buccal mucosa appeared hydrated. There appeared to be loss of subcutaneous fat as well as mild dehydration. The lack of skin turgor and loss of subcutaneous substance made blood drawing difficult for the trained phlebotomists because of the mobility of veins.

11. Bloom, W.L. Am J Clin Nutr 20:157, 1967.

12. Ashley, B.C.E. and H.M. Whyte. Aust J Exp Biol Med Sci 45:245, 1967.

13. Bloom, W.J. and G.J. Azar. Arch Intern Med 112:333, 1963.

The highly significant (t value= 15.92, 121 degrees of freedom, paired "t" test) increase in serum potassium immediately post restriction reflected a mean value above the accepted range of normalacy. In fact some trainees had values sufficiently high (6.8 - 6.9 mEq/L) to be associated with hyperkalemic toxicity. While a portion of the increase in serum potassium could be explained bby breakdown of lean body tissue to supply calories with resultant release of potassium (K) such a K load should have been handled by the kidneys. (The mean weight loss of the 16 trainees with serum potassium of 6.1 mEq/L or higher was 10.6%.) The only feasible explanation for the marked rise in serum K and drop in serum phosphorus is that metabolic acidosis was present. During metabolic acidosis both sodium and potassium are forced out of the intracellular space and, if not promptly disposed of by the kidneys, the serum potassium levels will increase. Similarly, as may be noted in the metabolic acidosis due to diabetic ketoacidosis, phosphates are used as buffers by the kidney and are lost in the urine with resultant decrease in serum phosphorus. The metabolic acidosis observed here can be explained by the semistarvation - ketoacidosis - complicated by the heavy physical exertion (lactic acidosis) demonstrated by many of the trainees and their reduced urine volumes. The limited urinary parameters measured substantiate this impression.

Electrocardiograms had been obtained on each trainee undergoing performance testing prior to treadmill walking. The jungle caloric restriction phase had been terminated late in the evening upon return to the base camp at Eglin AFB, Florida. Blood and urine specimens and anthropometric measurements were obtained very early the next morning. After administratively clearing the base camp the trainees were transported by bus back to Ft. Benning late that same day. The first performance testing on the 14 trainees occurred the following morning, at least 33 hours after completion of the training. Electrocardiograms were obtained on 23 of the trainees during the first full day back at Ft. Benning and the other two on the second day. The electrocardiograms were, for the most part, quite similar to those previously taken, however two or three did contain minimal changes compatible with early potassium intoxication. That was a post hoc observation. Sufficient time had transpired before the electrocardiograms were obtained to correct the electrolyte imbalance in these normal young adults.

The post jungle training blood sample revealed a significant increase in the number of individuals with deficient serum iron and transferrin saturation values (Table 8). In addition the mean value for total protein dropped significantly with one individual having a less than acceptable value. The 2.3% decrease in serum proteins may suggest depletion of body protein stores, as noted above, associated with the extended period of caloric restriction. Yamaji[14,15] has reported decreases in serum proteins during heavy physical training and suggested

14. Yamaji, R. J Physiol Soc Jpn 13:476, 1951.
15. Yamaji, R. J Physiol Soc Jpn 13:483, 1951.

that these proteins may be part of the body's labile protein stores[16] which could be depleted during stress. The 36.7% increase in serum ascorbic acid levels may have been due to the citrus fruit and juices from the dining hall and vitamin C fortified instant coffee from the rations. While there was a significant rise in hemoglobin values suggesting hemoconcentration, the lack of significant change in the hematocrits and serum sodium suggest that hemoconcentration, if present, was not significant. This suggests that the clinical evidence of dehydration was due directly to the water loss associated with semistarvation[1,9].

To assess the extent of any decrement in physical performance capabilities that may have occurred during training and the associated caloric restriction and weight losses, maximum performance tests were conducted on the treadmill. The initial treadmill test was conducted during the week before the cycle on early arriving trainees. Although the cadre recommended that we perform the majority of these tests on officers, since the rate of completion of training for officers was much higher than for enlisted trainees, it was not possible to restrict the study to the officers because they were granted leaves and passes during this period while awaiting training. Approximately one third of the tests were on officers. From reports by the cadre, it was anticipated that about 50% of the enrollees would not complete the course. Sixty-two men were measured on the treadmill during this pretraining week. Twenty-six of these men completed training and after training measurements were completed on 25 men. Fourteen of these 25 trainees performed another maximum performance test during the first day upon return to Ft. Benning, within 36 hours of the caloric restriction-jungle training when some of of the effects of this stress would would still be present. The posttraining test (indicated as Recovery in the tables) was conducted 3 to 4 days after the caloric restriction-jungle training phase was completed to allow the men to have some time to recover from the transient effects of caloric restriction and associated reduced body water as well as the fatigue of a 12-day exercise with minimum sleep.

Significant decrements in most of the maximum performance measurements were observed immediately after training and many of these decreases were also found during standardized submaximum performance. Since the men stopped the treadmill test 2.7 minutes sooner, the treadmill grade was less by the same amount so that all of the measurements of maximum performance were reduced. Some of these effects may be attributable to fatigue and inability to continue the test, the metabolic acidosis and partially to fatigue-induced lack of motivation to continue. The Balke Index includes body weight as a factor so that the weight loss contributed to the 16% decrease of this score. Since the

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16. Allison, J.B. and R.W. Wannemacher, Fr. Am J. Clin Nutr 16:445, 1965.

man performed less work, his oxygen consumption, carbon dioxide production, ventilation volume, heart and respiration rates were correspondingly reduced. Although some increases in the performance measurements were noted after 3 days of recovery when most of the transient effects of fatigue and metabolic acidosis should have disappeared, most of the decrements were still present, including reduced work time, oxygen debt and consumption, Balke Index, heart rate, ventilation volume, and carbon dioxide production. These data led to the conclusion that physical performance capacities, at least those measurable by this treadmill technique, were reduced by the end of training and a portion of these decrements persisted for at least 3 to 4 days.

The comparison of results of the pretraining treadmill test of men who completed the training cycle to those of men who were dropped before the sixth week revealed only subtle differences. Therefore, even if these tests were given as a screening test, the results would not be helpful in predicting who would complete training. The greatest difference was in the PFI scores which are based on the rates at which the pulse returned to normal. The better the physical condition of a man, the faster his heart rate will drop after strenuous exercise and the higher the score. Therefore, these scores reflect the expected; the men who were less physically conditioned did not complete training.

In Table 17, the estimated energy expenditure and daily caloric deficit revealed significant differences between those trainees who lost more than 10% of their body weight as measured immediately after the dietary restriction phase of jungle training compared to their initial body weight vs those losing less than 10%. The work performance data were evaluated to determine if any difference existed between the two weight loss groups for the performance tests conducted on the day after caloric restriction. No significant differences could be detected though the number of subjects was small.

As previously stated the data from the 8 Laotian and 2 Indonesian officer and one of the American military personnel were excluded from Table 17 and Figure 2. Of the 10 Oriental officers, 7 were less than 60 kilograms while the other three weighed slightly over 60 kilograms at the beginning of training. All but one gained weight during the Camp Darby phase of the cycle and the majority gained consistently until the dietary restriction portion of the jungle training phase during which they all lost weight. The one American who was excluded actually gained weight during the caloric restriction phase. As can be seen from his data presented in Appendix D, his apparent daily caloric expenditure of 17.2 kcal/kg would not have been sufficient for his basal metabolic needs, to say nothing of the energy needs imposed by the training. He was one of the trainee leaders appointed by the cadre. He completed the training cycle with a sufficiently high rating by the Center cadre to graduate, hence it can be assumed that he was physically performing at an above average level. Considering that his skinfold measurements and body circumference stayed approximately the same or increased during this "dietary restriction" phase, the weight gain must be considered valid. It became apparent that this individual had to be receiving additional food over and above that issued to the rest of the trainees. Based on the estimated average daily caloric expenditure (4,055 kcal/day) and the caloric equivalent of his weight gain, he would have had to received the equivalent of 41.4 MCI meals in this period as compared to the 13 meals provided each of the other trainees. While barter of food between trainees undoubtedly took place and may explain some of the very high calculated energy expenditure values (in those bartering away high energy items), it appears unlikely that it could be considered as the source of the extra energy consumed by this trainee leader. While the data from this individual were excluded from Table 17, his data were included in data presented in Tables 2,3,4,5,6, and 7.

Copies of the Ranger trainees' final scores were obtained and correlation analysis were calculated against weight changes. No relationships could be established between either the total score or any of its parts, and any or all of the weight changes. Since a large portion of the trainees' grading is subjective by both cadre and peers, the lack of correlations were anticipated.

In the 1964 Ranger Survey the energy requirement averaged 4,842 kcal/man/day. During the caloric restriction phase in 1973 at Eglin AFB, the estimated caloric expenditure was 4,020 ± 900 kcal/man/day (See Appendix A). Using a different research approach, it is noted above that for the same jungle caloric restriction phase, the estimated expenditure was 4,055 ± 590 kcal/man/day. These estimates of energy requirements between the studies are quite disparate and need explanation. There are a number of factors which have a bearing on the apparent discrepancy in the results; a few of which will be discussed.

The study conducted in 1964 addressed only the 16 days of the Ft. Benning/Camp Darby phase of the Ranger training cycle. The approach used during that study was labor intensive and included time-motion studies of the Ranger trainees throughout that portion of the training cycle. The oxygen consumption (energy expenditure) for many of the Ranger training activities had not previously been measured and were determined using USAMRNL team personnel performing the tasks under actual field training conditions. In addition, all food consumed, including that provided by the dining facilities both in garrison and in the field as well as food procured from outside sources was measured and nutrient consumption was accurately determined. Based upon the time-motion studies the training at Ft. Benning/Camp Darby required the expenditure of 4,249 kcal/man/day. However, it was demonstrated that the men were consuming an average of 4,129 kcal from food procured from the dining facilities and 272 kcal/day from outside the dining facilities for a total of 4,401 kcal/day. Despite an apparent over consumption of calories in relation to energy expenditure determined by time-motion studies, the men lost weight. During the period of the study the weight loss sustained was equivalent to 442 kcal/man/day. When the caloric equivalency of the weight loss was added to the known consumption, it was noted that the men were utilizing 4,846 kcal/day.

In 1973 when the USAMRNL was directed to conduct the current study as requested by the Ranger Department, USAMRNL was already committed to conduct a number of other studies that had to be completed prior to the transfer of the function scheduled to occur late in 1973. Due to the impending transfer of function, military and civilian personnel were being lost without replacements. At the time of the 1964 study authorization for increased rations for the mountain and jungle phase of the Ranger training cycle were already in effect. In 1973, the request for an increase in authorization for all phases had to be evaluated. Hence an eight week study was necessary. Due to the USAMRNL personnel losses and commitments, it was impossible to measure food consumption on a daily basis. There was only one phase of the training cycle in which food consumption was sufficiently controlled to permit an estimation of energy expenditure. That was during the jungle caloric restriction phase. However, we have no way of validating that the physical activity during this phase was equivalent to that required (and previously measured during the 1964 study) for the Ft. Benning phase of the cycle or that required at the mountain camps.

From the dietary histories of a select population described above, it was stated that the food intake provided the men during the 1973 Ft. Benning/Camp Darby phase of training was adequate. This is reflected in a relatively low consumption of food procured from outside the dining facilities. Despite this, it can be determined from Table 8 that there was a weight loss which averaged 0.96 kg of body fat/man for that period. That would have been equivalent to 393 kcal/man/day. If it could be assumed that the men were consuming from the dining facility at least the equivalent to that consumed in 1964 i.e. 4,129 kcal/man/day, with an additional 190 kcal being procured daily from outside sources and a caloric equivalent of the fat loss of 393 kcal/day, the total expenditure for this period would have been 4,712 kcal/man/day or only 135 kcal less than that calculated in 1964. When the data from the Ft. Benning/Camp Darby phase studied in 1964 are compared to the results obtained during 1973 and assumptions are made pertaining to food intake, energy requirements between the two studies are not greatly different.

Two additional factors should be considered in evaluating the differences between the 1964 and 1973 data. In 1964 the study was conducted between 27 Nov and 20 Dec. It was quite cold in the field and during the field studies the men did not have sleeping bags to guard against the cold, hence increasing the need for energy to maintain body warmth. This was not true during the July-Sept 1973 study. In addition the Ranger Department personnel had indicated that the training cycle selected by USAMRNL for study in 1973 was not ideal. Problems arose because of the very mixed backgrounds of the students participating, including a very large number of foreign trainees. All of problems tended to increase the need for familiarization training and a decrease in the vigor of the training. It was suggested that it would be better if the study could be conducted later in the year, but unfortunately due to MRNL's other commitments that was not possible.

The Ranger training program is designed to: train men in survival techniques; increase self confidence; and improve self discipline. In view of the environmental stresses and physical activities during the jungle phase, it is seriously questioned whether the caloric restriction has to be severe enough to produce a metabolic acidosis. While the personnel under going the training are normal, healthy individuals who should rapidly recover from a period of metabolic acidosis, one wonders whether their capability for assimulating maximal training opportunities is impaired by this period of metabolic acidosis. The studies described above have not addressed that problem.

CONCLUSIONS

Our data confirmed the report of the Ranger Department; the Ranger trainees have large losses of body weight during portions of the 8-week training cycle. Since the training protocol has extended periods of caloric restriction (some quite severe), body weight loss was expected and therefore only the magnitude and the physiological significance of these losses required documentation. Although over half of the average losses could be attributed to fat, the losses of protein and water were excessive and should not be tolerated. A small subpopulation indicated during interview that the men consumed about 12,100 kcalories from sources outside of the military dining room before the jungle exercise. This would be equivalent to 3.5 lb of body weight per man. The observed weight losses averaged 9.4% (maximum 17.5%) of the average initial weight. Therefore, without the supplemental calories from other sources, weight losses could have averaged nearly 12%.

From the limited blood biochemical constituents examined, the indications of the nutritional stress were: the increased percentage of trainees with less-than-acceptable values for hematocrits, serum iron concentrations, and transferrin saturation; the slight but significant decrease of serum proteins which suggests a depletion of labile protein stores; and the marked increase in serum potassium, with a decrease in serum phosphorous indicating the presence of a significant though transient metabolic acidosis.

The various measurements of physical performance capacities on the treadmill showed decrements of 10 to 15% immediately after the caloric restriction-jungle training. Although several factors including fatigue, metabolic acidosis and reduced total body water may have contributed to these decreases, the major portion of each of the decrements was still observed 3 to 4 days after training was completed when water balance should have been normal, the metabolic acidosis should have been corrected and the men had the opportunity to obtain a few good nights of rest. The loss of lean body mass due to catabolism of tissue protein to satisfy a caloric deficit would not be corrected in this time frame. The effects of fatigue after the strenuous field exercise would be anticipated; but the longer term detrimental effects upon performance should be prevented if possible.

RECOMMENDATIONS

1. Daily food issues should be increased 10% during the first phase of training at Ft. Benning and Camp Darby.

Comment: An additional 350 to 400 kcal should prevent weight losses even if the men could not purchase any food from other sources. Although the Master Menu provides 4,600 kcal/day as issued, normal preparation and cooking losses and unavoidable plate "waste" are between 14% and 24% thereby the consumed calories are reduced to 3500 to 3950 kcal/day. When surplus commodities, including milk, were available, the basic issue could be readily supplemented. This obviously happened during the 1964 survey when the men were consuming 4,120 kcalories within the military dining facility. When surplus commodities are unavailable, supplementation of the basic issue is no longer possible.

2. Daily food issue should be increased 15% for Class A meals fed during mountain and jungle training phases.

Comment: With the 9 missed meals during mountain training, additional food should be provided when the men are consuming Class A meals. These 500 to 600 kcal/day would only prevent the weight losses observed during the study and not replace the outside-the-dining hall consumption. The additional food after the 12-day 1200 kcal/day period would provide some excess calories to correct the metabolic acidosis associated with the weight lost during the vigorous jungle exercise and should reestablish water balances sooner.

3. Consideration should be given to issue of at least 16 MCI meals or their equivalent during the 12 day caloric restriction jungle phase.

Comment: The additional meals would be used after periods of very strenuous or prolonged physical exertion, not as rewards, but to counter or prevent the adverse mental and physical consequence of metabolic acidosis.

General Comment: Although energy expenditure was not measured during this evaluation, the Ranger Department states that training now averages 132 hr/wk compared to 102 hr during the 1964 study. Even if this expenditure had not increased, this level of work would require at least a 20% increase in the ration issue to maintain energy equilibrium without considering the 15 days of 1,200 kcal/day and 3 days of 2,400 kcal/day intakes during the combat simulation exercises. Therefore, the 15% recommended increase can be considered conservative. These additional calories should permit the men to start the extended severe calorie restriction phases with their weight near their initial body weight. Therefore, the loss of 10 to 15 lb during this period would not be added to losses previously incurred and should not be as detrimental to health.

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APPENDIX A
SURVEY OF TRAINEES OF THE RANGER TRAINING CENTER, RANGER DEPARTMENT, FT. BENNING, GEORGIA

Calculated daily energy expenditures.

The calculation of daily energy expenditures of the North American trainees based on 3500 kcal/lb (7700 kcal/kg) of body weight and assuming intakes of 1200 kcal/one MCI, provided an average of 5090 ± 780 kcal/day during the caloric restriction-jungle training phase if the weights for the first postrestriction morning were used. However, the body composition data indicated some weight loss resulted from body water loss (negative water balances associated with caloric restriction are well documented from both this and other laboratories) therefore, this figure would be an over-estimate of energy expenditure. If we assume that 3700 kcalories were consumed during the first day after restriction when no food purchases from outside-the-dining hall sources were permitted and if we use the second morning weight, the average estimated caloric expenditure would be reduced to 4020 ± 900 kcal/day. Since the consumable calories from the Master Menu are about 3600 to 3800 kcal/day, a 15% increase in issued rations would be required to maintain caloric equilibrium in the majority of the men. Maintaining caloric balance in 83% of the men would require 4900 kcal/day (based on the 4020 ± 900 kcal/day estimate). The Far Eastern foreign nationals, being of smaller stature and lesser body weight, had a daily energy expenditure of 4430 ± 480 kcal if the first postrestriction morning's weight was used in the calculation or 3440 ± 430 kcal/day if the second postrestrictive morning's weight was used in calculation. The latter figure would be consistent with the observed weight gain of 1.78 ± 1.06 kg/man during the training before the 12-day exercise. The 41 gm/day weight gain would be equivalent to 320 kcal/day, which would then equal a total intake of 3760 kcal/day. The North Americans lost 1.05 kg of weight before restriction (190 kcal/day deficit); however, the caloric deficit for the 3 days with 1 meal and 3 days with 2 meals/day during mountain training was 10,800 calories (equivalent to 1.40 kg). These men maintained caloric balance by the consumption of about 400 kcal/day from outside-the-dining hall sources. If we subtract these calories from the 4020 Cal/day estimated expenditure, we find that the dining halls were supplying about 3620 kcal/day. This confirms the figure 3600 to 3800 kcal/day consumed from the 4500 to 4600 issued calories in the food supplied by the Master Menu with 15 to 20% lost through all wastes including storage, preparation, cooking and plate waste.

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COMPARISON OF THE INITIAL WEIGHTS OF TRAINING CYCLE FINISHERS VS NON FINISHERS

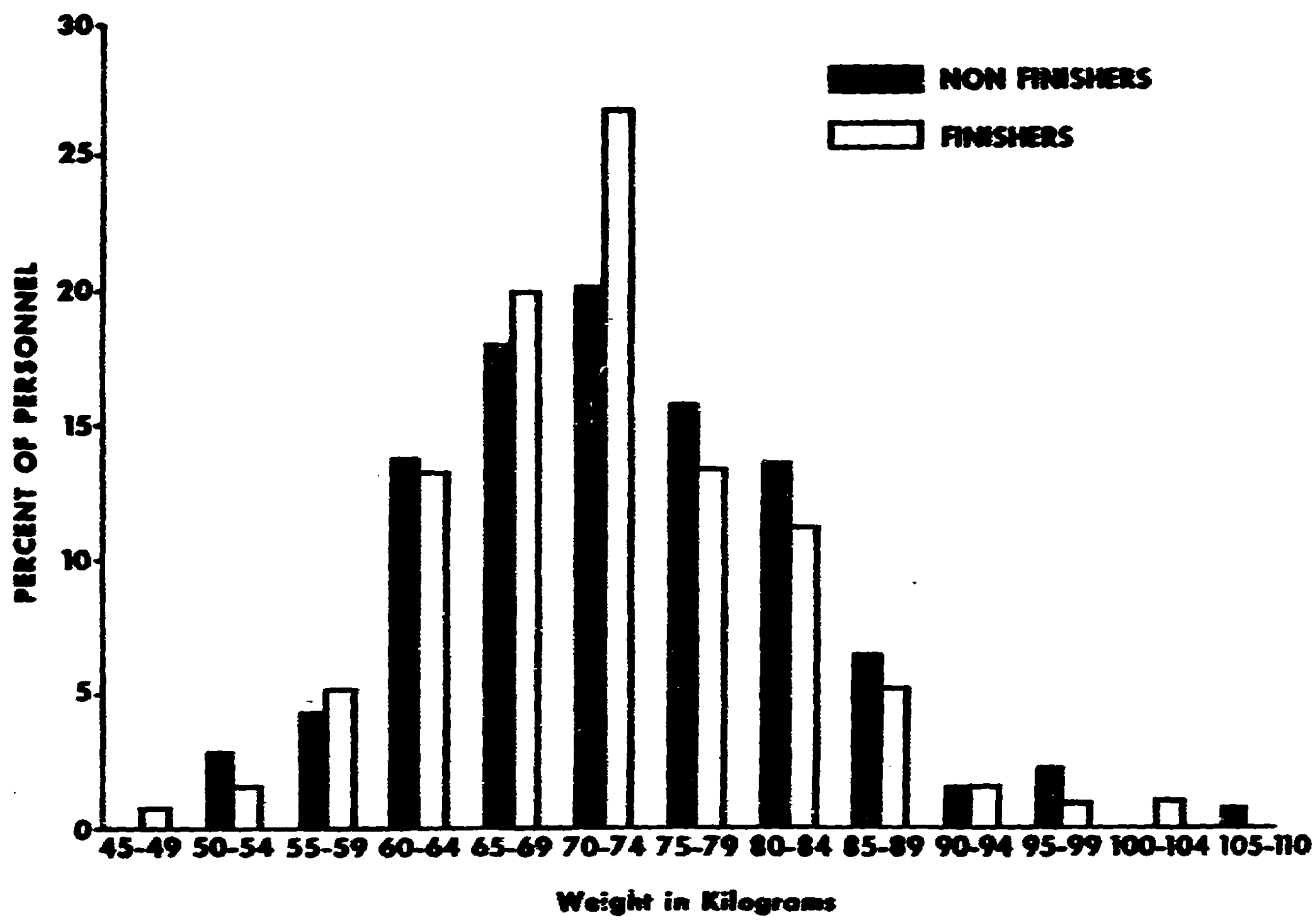
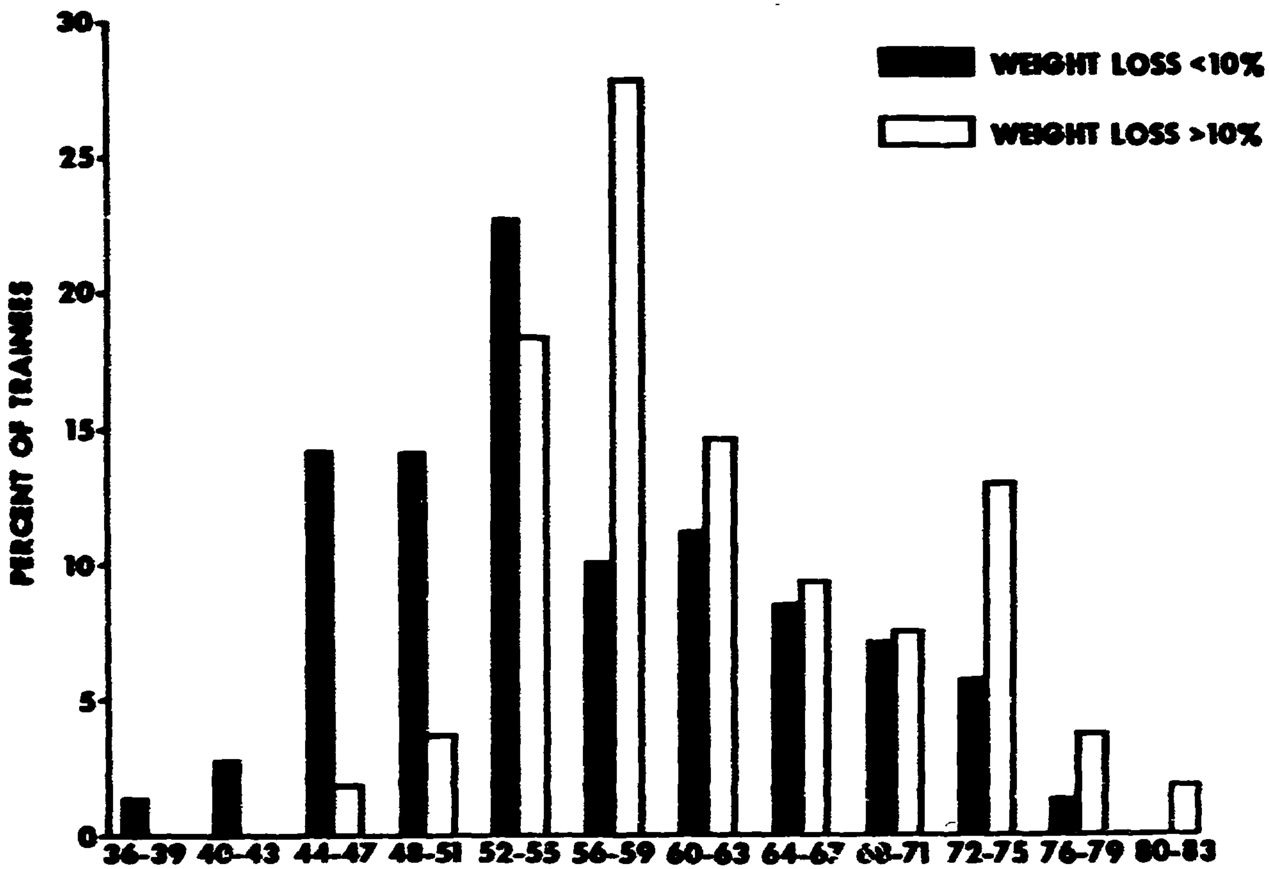


FIGURE 1

DAILY ENERGY EXPENDITURE DURING JUNGLE DIETARY RESTRICTION PHASE



Daily Energy Expenditure — Kilocalories/Kilogram

Weight loss determined by initial Body weight compared to first weight after jungle dietary restriction

FIGURE 2

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TABLE 1. Schedule of measurements.

Julian Date	Phase	Activity	Laboratory Tests and Measurements Scheduled
204-213	Pretraining or control	Details/passes awaiting training	Body weights, urine chemistries, blood chemistries, skinfolds, complete anthropometry, treadmill performance.
232	End of Benning	Completed physical training, classroom, short field exercises.	Body weights, urine chemistries, skinfolds, 3 body diameters.
249	End of mountain	Mountaineering with 3 days of 2 meals and 3 days of 1 meal per day.	(Same as 232)
255	Jungle, end of prerestriction	Classroom, jungle tactics	(Same as 232)
267	Jungle, post-restriction	Completed 12-day strenuous jungle exercise on 1 meal per day. Food restricted to dining hall.	(Same as 232) Add: blood chemistries.
268	Recovery day 1	Clean-up details; food ad libitum.	(Same as 232) Add: Treadmill performance (14 men).
269	Recovery day 2	Details, food ad libitum.	Body weights; urine chemistries.
270	Recovery day 3	Graduation	Body weights; urine chemistries; treadmill performance.*
271			Treadmill performance+

*16 men
+Only 9 men

TABLE 2. Body weights and circumferences.

Time of Measurement	Weight kg Av	Weight kg SD	Body circumferences (cm) Chest Av	Chest SD	Waist Av	Waist SD	Buttocks Av	Buttocks SD
Pretraining	72.13^{a}	± 9.19	88.81^{a}	± 5.49	81.20^{a}	± 6.44	94.20^{a}	± 5.17
After Benning	71.74^{b}	± 8.48	87.62^{b}	± 5.24	79.32^{b}	± 5.09	93.87^{b}	± 5.07
After mountain	70.26^{c}	± 8.05	86.89^{c}	± 5.31	77.26^{c}	± 4.95	92.76^{c}	± 4.67
Prerestriction	71.30^{d}	± 8.10	89.34^{a}	± 5.02	80.63^{d}	± 4.70	94.34^{a}	± 4.52
Postrestriction	65.37^{e}	± 7.58	85.31^{d}	± 4.73	75.86^{e}	± 4.60	91.07^{d}	± 4.56
Recovery, Day 1	67.05^{f}	± 7.55	87.33^{b}	± 4.62	78.09^{f}	± 4.46	90.97^{d}	± 4.27
Recovery, Day 2	69.51^{g}	± 7.76						
Recovery, Day 3	70.62^{c}	± 7.92						

[a] Means with same superscript letters are not significantly different.

TABLE 3. Body circumferences and diameters measured in centimeters pretraining and posttraining.

Site	Pretraining Av ± SD	Posttraining Av ± SD	Significance[1]
Circumferences			
Right forearm	27.85 ± 1.56	27.31 ± 1.37	0.001
Left forearm	27.32 ± 1.63	26.93 ± 1.43	0.001
Right biceps	30.38 ± 2.09	28.45 ± 1.76	0.001
Left biceps	29.97 ± 2.27	28.08 ± 1.79	0.001
Right calf	38.15 ± 2.27	37.52 ± 2.45	0.001
Left calf	37.81 ± 2.26	37.31 ± 2.41	0.001
Diameters			
Bideltoid	46.89 ± 2.23	45.95 ± 1.87	0.001
Bihumeral	48.78 ± 2.62	47.40 ± 2.19	0.001
Lateral chest	31.14 ± 2.14	30.04 ± 1.73	0.001

[1]Most significant level attainable from paired-t statistic.

TABLE 4. Skinfold thicknesses.

Time of Measurement	Skinfold thickness (mm)[1]			
	Rt triceps	Lt triceps	Rt scapula	Lt scapula
Pretraining	8.27[a] ± 3.10	8.50[a] ± 3.19	10.74[a] ± 3.59	10.74[a] ± 3.78
After Benning	7.62 ± 2.52	7.82 ± 2.71	9.97 ± 2.83	10.05 ± 3.12
After mountain	6.40 ± 2.00	6.38 ± 2.60	8.50 ± 1.95	8.41 ± 1.97
Prerestriction	6.73 ± 1.90	6.87 ± 1.93	9.14 ± 2.00	9.04 ± 1.98
Postrestriction	5.81 ± 1.52	5.85 ± 1.63	7.98 ± 1.49	7.95 ± 1.49
Recovery, Day 1	5.21 ± 1.60	5.24 ± 1.58	7.67 ± 1.61	7.59 ± 1.62

[1]Averages and standard deviations.

[a]Each value significantly different from all others in that column.

TABLE 5. Comparisons of body weight and fat changes.

Period of change	Weight change kg	Weight change lb	Fat change[1] kg	Fat change[1] lb
Pretraining through Benning	−0.39	−0.86	−0.96	−2.11
Pretraining through mountain	−1.87	−4.11	−2.44	−5.37
Pretraining until restriction	−0.83	−1.83	−0.21	−0.46
Pretraining through restriction	−6.76	−14.87	−3.85	−8.47
Pretraining through 1 day recovery	−5.08	−11.18		
Pretraining through 2 days recovery	−2.62	−5.76		
Pretraining through 3 days recovery	−1.51	−3.32		
During mountain training	−1.48	−3.26	−1.48	−3.26
Between mountain training and restriction	+1.04	+2.29	+2.34	+5.15
During restriction	−5.93	−13.05	−3.58	−7.89
During restriction & recovery	−0.68	−1.50		

[1] Fat changes were calculated from changes in percent body fat calculated from the formula: % body fat = $100 \dfrac{(-0.00640 \times wt + wt + 0.44050 \times buttocks + 0.48951 \times waist - 0.0512 \times Ht - 58.65713)}{Wt}$

TABLE 6. Urinary values[1].

Time of Measurement	Specific Gravity	pH	Incidence of Positive Reactions[2]			
			Glucose	Ketones	Occult Blood	Protein
Pretraining	$1.026^{a} \pm .004$	$5.05^{a} \pm .30$	$0/132^{a}$	$1/132^{a}$	$2/132^{a}$	$6/132^{a}$
After Benning	$1.031^{b} \pm .006$	$6.01^{b} \pm .18$	$0/133^{a}$	$0/133^{a}$	$0/133^{a}$	$7/133^{a}$
After mountain	$1.026^{a} \pm .008$	$5.34^{c} \pm .49$	$1/134^{a}$	$12/134^{b}$	$0/134^{a}$	$52/134^{b}$
Prerestriction	$1.024^{a} \pm .006$	$5.74^{d} \pm .62$	$1/134^{a}$	$0/134^{a}$	$0/134^{a}$	$45/134^{b,c}$
Postrestriction	$1.030^{b} \pm .008$	$5.04^{a} \pm .19$	$0/131^{a}$	$9/131^{b}$	$0/131^{a}$	$70/131^{d}$
Recovery, Day 1	$1.026^{a} \pm .008$	$5.33^{c} \pm .47$	$1/133^{a}$	$3/133^{a}$	$0/133^{a}$	$37/133^{b,c}$
Recovery, Day 2	$1.026^{a} \pm .004$	$5.68^{d} \pm .79$	$1/133^{a}$	$1/133^{a}$	$0/133^{a}$	$26/133^{c}$
Recovery, Day 3	$1.022^{c} \pm .006$	$5.41^{c} \pm .54$	$0/133^{a}$	$0/133^{a}$	$0/133^{a}$	$13/133^{a}$

[1] Averages and standard deviations.

[2] Figures represent the number of positive reactions/total number of urines examined.

[a] Means with like superscripts were not significantly different.

TABLE 7. Blood values (mean ± SD).

Value Measured	Pretraining Av	SD	Posttraining Av	SD	Significance[1]
Vitamin C (mg/dl)	0.79 ±	0.28	1.08 ±	0.26	0.001
Hemoglobin (g/dl)	15.29 ±	1.05	15.70 ±	1.02	0.001
Hematocrit (% cells)	44.4 ±	2.4	44.2 ±	2.7	NS
Iron (ug/dl)	100.4 ±	28.5	99.9 ±	29.6	NS
Iron binding capacity (mg/dl)	293.0 ±	49.0	283.0 ±	33.0	0.05
Transferrin saturation (%)	35.1 ±	11.8	35.5 ±	10.3	NS
Serum calcium (mEq/L)	4.88 ±	0.29	4.95 ±	0.21	NS
Serum phosphorus (mg/dl)	4.32 ±	0.66	4.04 ±	0.43	0.001
Serum sodium (mEq/L)	139.6 ±	3.9	140.5 ±	2.6	NS
Serum potassium (mEq/L)	4.1 ±	0.4	5.2 ±	0.6	0.001
Serum protein (g/dl)	7.73 ±	0.47	7.55 ±	0.42	0.001

[1]Greatest level of significance obtainable from paired-t statistics.

TABLE 8. Number of biochemical values less than acceptable, training cycle finishers.

	Ascorbic Acid	Hemoglobin	Hematocrit	Serum Iron	% Transferrin Saturation	Total Protein
Pretraining	- (131)	12 (131)	41 (131)	6 (128)	3 (128)	- (131)
Posttraining	- (134)	5 (134)	49 (134)	14 (133)	10 (130)	1 (134)
Less Then Acceptable Both Pre & Post Training	-	2	24	2	1	-

( ) = Number of determinations.

TABLE 9. Number of training cycle finishers with two or more "Less Than Acceptable" values for separate parameters.

	2	3	4
Pretraining	15	2	2
Posttraining	17	3	1

TABLE 10. Values for maximum work performance.

No. of Men	Pretraining Av		Pretraining SD	Immediately After Training Av		Immediately After Training SD	Recovery Av		Recovery SD
Time to Exhaustion (min)									
14	24.82	±	2.91	22.11[a]	±	2.72	22.86[a]	±	2.08
25	25.04	±	2.45				22.66[a]	±	2.79
36	23.66	±	3.00						
Work Oxygen Consumption (liters)									
14	49.75	±	9.90	36.69[a]	±	10.22	41.46[a,b]	±	10.04
25	50.45	±	7.86				39.76[a]	±	9.63
36	42.70[c]	±	12.03						
Total Oxygen Consumption (liters)									
14	54.58	±	10.50	40.13[a]	±	10.74	45.36[b]	±	10.52
25	55.05	±	8.38				43.49[a]	±	10.18
36	48.46[c]	±	10.27						
Balke Index									
14	1613.6	±	236.8	1353.8[a]	±	255.3	1471.6[b]	±	200.9
25	1613.2	±	182.9				1441.2[a]	±	196.4
36	1499.0[c]	±	232.5						
Physical Fitness Index Scores									
14	170.0	±	34.2	174.6	±	27.9	160.9	±	18.2
25	170.2	±	30.4				162.1	±	26.0
36	150.1[c]	±	18.7						

[a]Significantly different from pretraining value.

[b]Significantly different from immediately-after-training value.

[c]Significantly different from values of 25 finishers.

TABLE 11. Pulse and respiration rates at various work levels.

No. of Men	Pretraining Av ± SD	Immediately After Training Av ± SD	Recovery Av ± SD
Heartbeats/min			
	Sitting Rest		
14	72.1 ± 15.4	63.9[a] ± 8.7	75.5[b] ± 17.8
25	73.3 ± 14.2		72.9 ± 15.5
36	72.1 ± 12.3		
	Submaximal Work		
14	137.0 ± 11.9	122.0[a] ± 12.8	138.2[b] ± 15.5
25	138.2 ± 12.3		135.8 ± 15.3
36	143.6 ± 12.5		
	Maximal Work		
14	190.5 ± 13.1	178.0[a] ± 15.0	186.2[b] ± 10.3
25	190.5 ± 12.6		183.6[a] ± 11.3
36	188.2 ± 11.8		
Breaths/min			
	Sitting Rest		
14	13.0 ± 2.4	12.2 ± 2.8	14.8[b] ± 3.6
25	15.6 ± 13.5		14.0 ± 3.1
36	14.3 ± 3.2		
	Submaximal Work		
14	21.2 ± 3.8	21.4 ± 4.3	23.2 ± 4.5
25	23.1 ± 4.6		24.9 ± 5.1
36	26.2[c] ± 5.3		
	Maximal Work		
14	37.9 ± 8.1	32.0[a] ± 4.1	34.0 ± 4.6
25	38.0 ± 7.8		35.3 ± 7.0
36	36.9 ± 8.4		

[a] Significantly different from pretraining value.

[b] Significantly different from immediately-after-training value.

[c] Significantly different from value of 25 finishers.

TABLE 12. Ventilation volumes at various work levels.

No. of Men	Pretraining Av	Pretraining SD	Immediately After Training Av	Immediately After Training SD	Recovery Av	Recovery SD
Liters (BTPS)/min						
	Sitting Rest					
14	9.13	± 2.22	8.88	± 2.02	11.36[a,b]	± 1.72
25	9.16	± 2.04			10.99[a]	± 1.88
36	9.11	± 2.42				
	Submaximal Work					
14	44.43	± 5.98	41.35[a]	± 4.27	47.32[a,b]	± 5.05
25	44.27	± 5.10			47.34[a]	± 4.89
36	46.29	± 7.71				
	Maximal Work					
14	111.24	± 22.40	86.70[a]	± 10.56	101.68[b]	± 15.96
25	113.75	± 18.70			99.40[a]	± 15.47
36	106.79	± 22.00				
Liters (STPD)/min						
	Sitting Rest					
14	7.67	± 1.87	7.30	± 1.67	9.31[a,b]	± 1.40
25	7.71	± 1.71			9.00[a]	± 1.53
36	7.67	± 2.04				
	Submaximal Work					
14	37.80	± 4.78	33.97[a]	± 3.52	38.77[b]	± 4.11
25	37.67	± 4.16			39.16	± 4.97
36	39.40	± 6.89				
	Maximal Work					
14	93.54	± 18.95	71.22[a]	± 15.98	83.34[a,b]	± 13.07
25	95.75	± 15.91			81.42[a]	± 12.74
36	89.95	± 18.51				

BTPS = Body Temperature, Ambient Barometric Pressure, Saturated with water.

STPD = Standard Temperature, Barometric Pressure, Dry.

[a]Significantly different from pretraining value.

[b]Significantly different from immediately-after-training value.

TABLE 13. Respiratory quotients (RQ) and carbon dioxide production at various work levels.

No. of Men	Pretraining Av ± SD	Immediately After Training Av ± SD	Recovery Av	Recovery SD
RQ				
	Sitting Rest			
14	0.83 ± 0.08	0.80 ± 0.06	0.87[a,b]	± 0.06
25	0.82 ± 0.07		0.88[a]	± 0.05
36	0.84 ± 0.07			
	Submaximal Work			
14	0.84 ± 0.05	0.92[a] ± 0.09	0.92[a]	± 0.06
25	0.85 ± 0.05		0.92[a]	± 0.05
36	0.90[c] ± 0.06			
	Maximal Work			
14	1.05 ± 0.07	1.06 ± 0.07	1.05	± 0.05
25	1.04 ± 0.07		1.04	± 0.06
36	1.05 ± 0.06			
Liters CO_2/min				
	Sitting Rest			
14	0.231 ± 0.047	0.234 ± 0.057	0.301[a,b]	± 0.035
25	0.233 ± 0.047		0.302[a]	± 0.049
36	0.248 ± 0.069			
	Submaximal Work			
14	1.687 ± 0.176	1.678 ± 0.185	1.812	± 0.169
25	1.690 ± 0.141		1.793[a]	± 0.161
36	1.734 ± 0.258			
	Maximal Work			
14	3.729 ± 0.605	3.211[a] ± 0.466	3.493[b]	± 0.389
25	3.733 ± 0.479		3.382[a]	± 0.420
36	3.494 ± 0.572			

[a]Significantly different from pretraining value.

[b]Significantly different from immediately-after-training value.

[c]Significantly different from value of 25 finishers.

TABLE 14. Oxygen consumption at various work levels.

No. of Men	Pretraining Av	Pretraining SD	Immediately After Training Av	Immediately After Training SD	Recovery Av	Recovery SD
Oxygen consumption (liters/min)						
	Sitting Rest					
14	0.281	± 0.052	0.296	± 0.059	0.336[a,b]	± 0.039
25	0.274	± 0.050			0.335[a]	± 0.044
36	0.293	± 0.076				
	Submaximal Work					
14	2.013	± 0.199	1.801[a]	± 0.123	1.980[b]	± 0.172
25	1.999	± 0.171			1.956	± 0.153
36	1.956	± 0.260				
	Maximal Work					
14	3.545	± 0.439	3.044[a]	± 0.514	3.344[a,b]	± 0.365
25	3.596	± 0.358			3.259[a]	± 0.360
36	3.350[c]	± 0.492				
Oxygen consumption (ml/kg/min)						
	Sitting Rest					
14	3.86	± 0.83	4.36	± 0.91	4.67[a]	± 0.62
25	3.77	± 0.73			4.69[a]	± 0.64
36	4.07	± 0.90				
	Submaximal Work					
14	24.49	± 2.65	27.04	± 1.96	27.41	± 1.82
25	27.50	± 2.47			27.31	± 1.47
36	27.22	± 2.44				
	Maximal Work					
14	48.43	± 6.20	43.05[a]	± 6.57	46.30	± 4.12
25	49.48	± 5.44			45.54[a]	± 4.69
36	46.73	± 6.21				

[a]Significantly different from pretraining value.

[b]Significantly different from immediately-after-training value.

[c]Significantly different from value of 25 finishers.

TABLE 15. Number of biochemical values less than acceptable, training cycle non-finishers. Specimens obtained pretraining.

Ascorbic Acid	Hemoglobin	Hematocrit	Serum Iron	% Transferrin Saturation	Total Protein
- (128)	9 (128)	38 (128)	11 (125)	10 (125)	- (128)

TABLE 16. Comparison of finishers vs non-finishers[1].

	Finishers	Non-Finishers	Significance
Initial weight (kg)	72.07 ± 9.16 (135)	73.31 ± 10.20 (138)	NS
Height (cm)	175.7 ± 7.0	176.5 ± 6.7	NS
Serum ascorbic acid (mg/dl)	0.79 ± .28 (131)	0.70 ± .29 (128)	$p = < 0.005$
Serum Iron (mg/dl)	100.2 ± 28.5 (128)	101.7 ± 34.5 (125)	NS

1 Mean ± Standard Deviation.

Significance determined by Students' "t" test. Numbers in ( ) indicate numbers of participants.

TABLE 17. Energy expendiute during jungle dietary restriction phase comparing trainees who lost less than vs those who lost more than 10 percent of initial body weight at conclusion of dietary restriction[1].

	< 10%	> 10%	Significance
Number of subjects	70	54	-
Average weight during restriction phase (kg)	69.24 ± 6.79	69.14 ± 7.90	NS
Mean daily caloric deficit (kcal)	2,584 ± 583	2,977 ± 596	p=<0.001
Mean daily energy expenditure (kcal)	3,884 ± 583	4,277 ± 596	p=<0.001
Mean daily energy expenditure (kcal/kg)	56.45 ± 9.07	62.89 ± 9.24	p=<0.001

1 Mean ± Standard Deviation.

Significance determined by Students' "t" test.

APPENDIX D

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APPENDIX D-1. Trainees with weight loss less than ten percent experienced during jungle dietary restriction phase.

Subject	Daily Energy Deficit (kcal/day)	Daily Energy Expenditure (kcal/day)	Average Weight (kg)	Energy Expenditure (kcal/kg)
1	1656	2956	56.26	52.55
2	2348	3648	63.34	57.60
3	2698	3998	64.66	61.84
4	2807	4107	74.09	55.44
5	2311	3611	80.09	45.09
6	1297	2597	64.63	40.18
7	2565	3865	62.83	61.52
8	2590	3890	60.35	64.46
9	2724	4024	61.09	65.87
10	2528	3828	68.86	55.59
11	2461	3761	71.93	52.29
12	2327	3627	70.18	51.69
13	2177	3477	64.35	54.04
14	2281	3581	81.28	44.06
15**	(-83**)	1217**	70.76**	17.20**
16	2298	3598	68.33	52.66
17	2269	3569	65.36	54.60
18	1393	2693	70.78	38.05
19	3266	4566	69.39	65.80
20	2206	3506	69.92	50.15
21	3070	4370	72.45	60.32
22	3003	4303	69.09	62.28
23	2156	3456	57.05	60.58
24	2532	3832	77.04	49.74
25	2861	4161	83.38	49.91
26*	3619	4919	75.63	65.04
27*	3196	4496	61.19	73.47
28*	3888	5188	67.44	76.94
29	1814	3114	65.48	47.56
30	2119	3419	75.63	45.20
31	2277	3577	60.42	59.21
32*	3619	4919	71.87	68.44
33	3262	4562	76.14	59.91
34	2411	3711	57.76	64.24
35	3403	4703	79.86	58.90
36	2820	4120	75.56	54.53
37	2578	3878	70.45	55.04
38	2778	4078	72.69	56.10
39	2820	4120	74.02	55.65
40	2098	3398	76.99	44.13

APPENDIX D-1. Trainees with weight loss less than ten percent-experienced during jungle dietary restriction phase. (Cont.)

Subject	Daily Energy Deficit (kcal/day)	Daily Energy Expenditure (kcal/day)	Average Weight (kg)	Energy Expenditure (kcal/kg)
41	1289	2589	59.75	44.33
42	2294	3594	78.30	45.90
43	2065	3365	72.98	46.10
44	2198	3498	70.46	49.65
45	2027	3327	72.21	46.07
46	2661	3961	57.10	69.37
47	3737	5037	70.59	71.36
48	2920	4220	67.06	62.92
49	2002	3302	72.78	45.37
50	2648	3948	73.64	53.62
51	3187	4487	60.70	73.91
52	1806	3106	62.50	49.70
53*	3690	4090	72.67	68.66
54	2674	3974	62.64	63.43
55	2127	3427	66.18	51.78
56	2461	3761	70.66	53.22
57*	3523	4823	66.36	72.68
58	2081	3381	68.63	49.27
59	2465	3765	69.64	54.06
60	2703	4003	60.63	66.02
61	3249	4549	80.64	56.41
62	2644	3944	80.09	49.24
63	2548	3848	84.52	45.53
64	2394	3694	66.56	55.50
65*	3978	5278	71.92	73.39
66*	3074	4374	62.81	69.63
67	2594	3894	63.11	61.71
68*	2336	3636	63.82	56.97
69	2240	3540	67.29	52.60
70	2340	3640	66.39	54.83
71	2394	3694	76.04	48.58

* Trainees who barely maintained or lost weight during the Jungle Pre-Dietary Restriction Phase.

** Data from this trainee leader excluded from statistical evaluations of the data for this group. See Text for explanation.

APPENDIX D-2. Trainees with weight loss greater than ten percent-experienced during jungle dietary restriction phase.

Subject	Daily Energy Deficit (kcal/day)	Daily Energy Expenditure (kcal/day)	Average Weight (kg)	Energy Expenditure (kcal/kg)
1*	3394	4694	63.07	72.84
2	3095	4395	58.48	75.15
3*	3292	4592	61.91	74.17
4	4025	5325	91.68	58.08
5	3195	4495	73.20	61.41
6	2302	3602	61.21	58.85
7	2890	4190	67.23	62.33
8	3132	4432	76.28	58.11
9	2978	4278	76.76	55.73
10*	3901	5201	88.62	58.69
11	3186	4486	85.04	52.76
12*	3228	4528	57.57	78.64
13	2803	4103	70.30	58.36
14*	3452	4752	64.17	74.06
15	2398	3698	64.03	57.76
16	2824	4124	63.39	65.05
17	2490	3790	67.10	56.48
18	2844	4144	58.92	70.34
19	2261	3561	62.29	57.16
20	3474	4774	78.95	60.47
21*	2509	3809	63.49	59.99
22	2732	4032	68.41	58.94
23*	3677	4977	66.72	74.60
24	2698	3998	78.64	50.85
25	3800	5100	69.97	72.88
26	2465	3765	66.31	56.78
27	2932	4232	88.52	47.81
28	2690	3990	71.32	55.95
29	2786	4086	71.49	57.16
30*	4325	5625	77.23	72.83
31	2586	3886	63.95	60.76
32*	4216	5516	74.04	74.50
33	3028	4328	62.26	69.52
34*	2977	4277	65.83	64.98
35	2404	3704	70.55	52.50
36	1868	3168	58.21	54.43
37	2774	4074	60.33	67.52
38	2907	4207	73.70	57.08
39	2565	3865	66.51	58.11

APPENDIX D-2. Trainees with weight loss greater than ten percent-experienced during jungle dietary restriction phase. (Cont.)

Subject	Daily Energy Deficit (kcal/day)	Daily Energy Expenditure (kcal/day)	Average Weight (kg)	Energy Expenditure (kcal/kg)
40*	3953	5253	68.83	76.31
41	3049	4349	64.92	66.99
42	3358	4658	68.30	68.19
43	3157	4457	72.76	61.26
44	3216	4516	78.08	57.83
45	1981	3281	62.67	52.36
46	2561	3861	69.22	55.78
47	3132	4432	68.83	64.39
48	2465	3765	68.44	55.04
49	3637	4937	78.30	63.05
50*	4075	5375	66.46	80.87
51	1689	2989	59.22	50.48
52*	2932	4232	68.07	62.18
53	2065	3365	63.72	52.80
54	2377	3677	67.82	54.22

* Trainees who barely maintained or lost weight during the Jungle Pre-Dietary Restriction Phase.

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